## Thermodynamics of Supercooled and Glassy Water

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The behavior of metastable water at low temperatures is unusual. The isothermal compressibility, the isobaric heat capacity, and the magnitude of the thermal expansion coefficient increase sharply upon supercooling, and structural relaxation becomes extremely sluggish at temperatures far above the glass transition [1,2]. Water has two distinct glassy phases, low- and high-density amorphous ice (LDA and HDA, respectively). The polyamorphic transition between LDA and HDA is accompanied by volume and enthalphy discontinuities, and appears to be first-order [3-4]. The understanding of these observations in terms of the global phase behavior of water at low temperatures remains incomplete [5-8]. In this lecture I will review the experimental facts, discuss their theoretical interpretation, and identify key unanswered questions.

Microscopic theories and computer simulations suggest several possible scenarios that can reproduce some experimental observations [5-9]. While no theory can explain all the facts, new and interesting concepts have resulted from this work, such as the possibility of liquid-liquid immiscibility in a pure substance [10-12]. The role of dynamics [13], the possibility that two calorimetrically distinct forms of liquid water exist below 150 K [14], and the relationship of water's polyamorphism to that of other network-forming fluids are some of the important open questions that deserve further experimental and theoretical consideration.

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